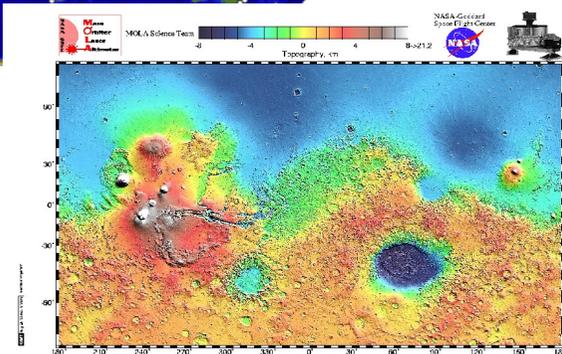


SCIENCE PRODUCTS



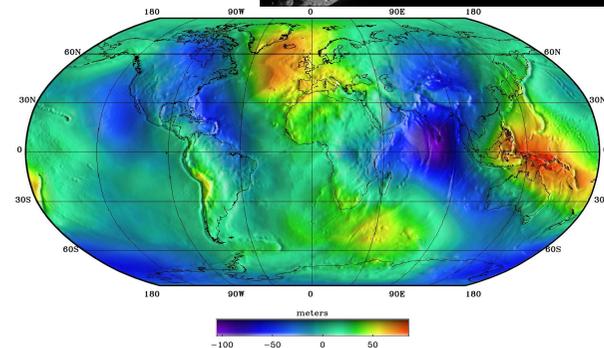
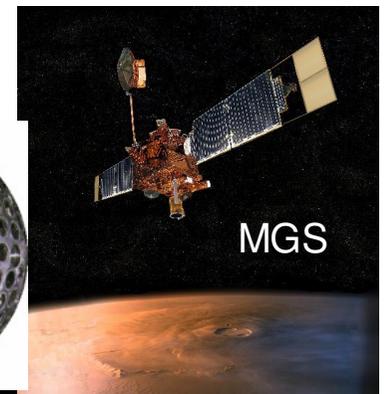
GMT Feb 29 17:28:58 2005



15th International Laser Ranging Workshop

Canberra, Australia

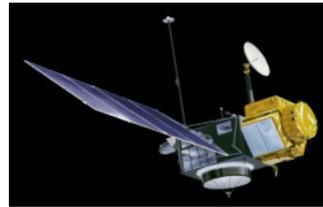
October 2006



SLR INVESTIGATION LIFE-CYCLE

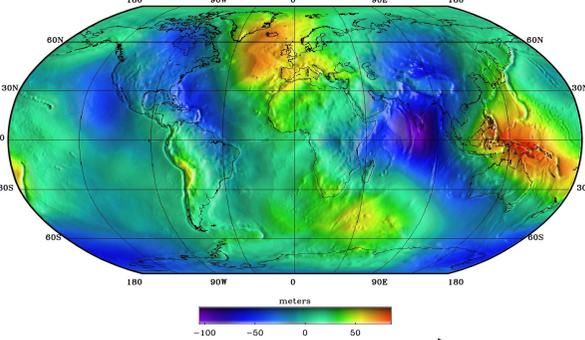
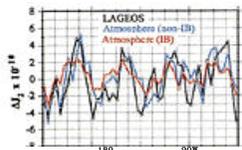
Instrument/Sensor Analysis

Sensor Data Calibrations
Use of Laboratory Data



Atmospheric Modeling

Tropospheric Refraction



Satellite Form

Modeling & Frame
S/C Attitude



Orbit Determination

Force Modeling
Global Data Evaluation
Orbit DQ

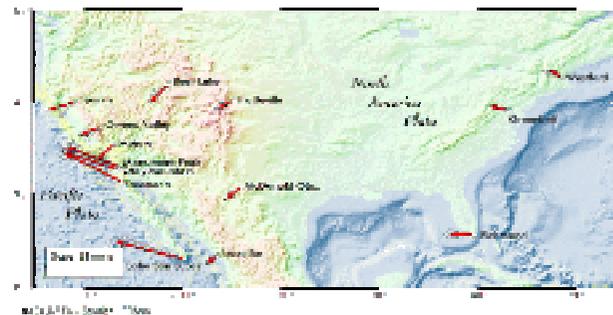


Tracking Data Analysis

Data QA
Tracking calibration
Instrument engineering

Science Products

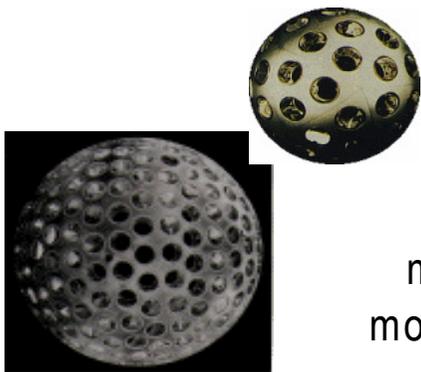
Geophysical Models
Analysis Methods
Science Interpretation



Reference Frame Modeling

Geocenter motion
Polar Motion and Earth Orientation

PRECISION ORBIT DETERMINATION



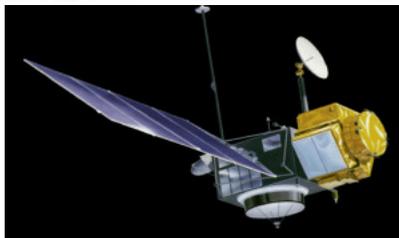
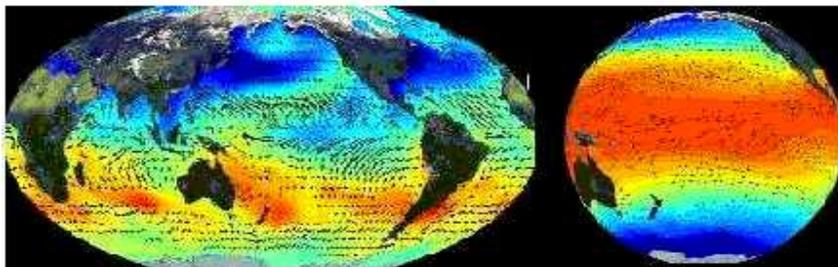
Satellite Laser Ranging

state-of-the-art precision OD
mm tracking site locations
mm/yr tectonic motion determination
monitoring time varying gravity effects

30 Years of
SLR Leadership

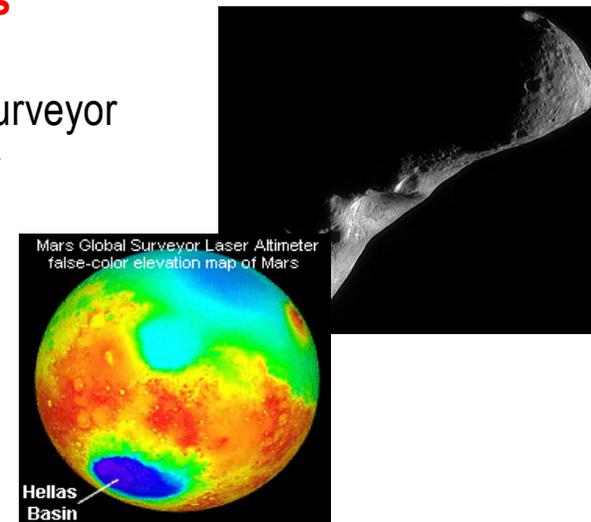
Altimeter Mission Support

± 2 cm orbits for TOPEX and Jason



Interplanetary Applications

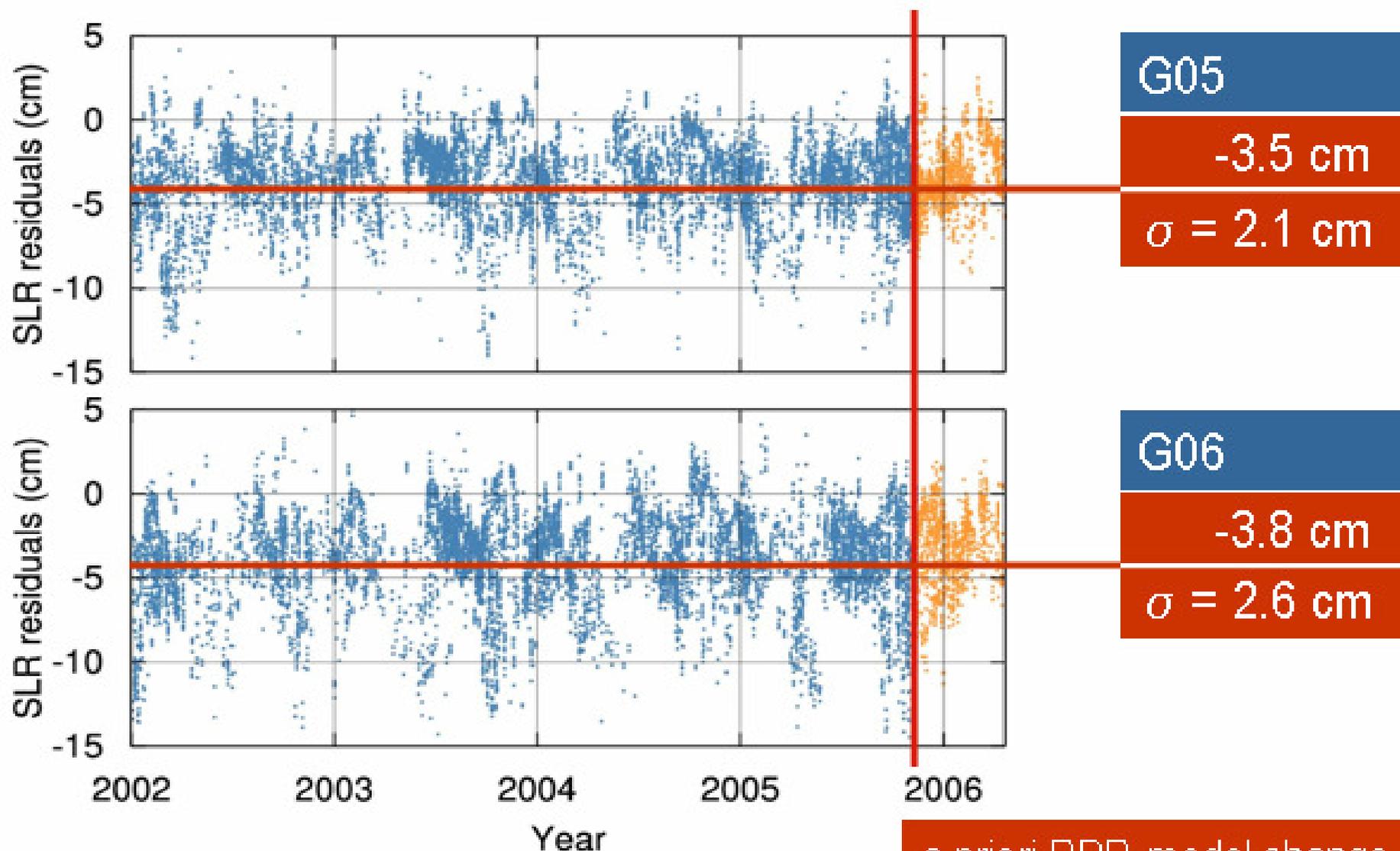
Precision Orbits for NEAR
2m Orbits for Mars Global Surveyor
assisted with Laser Altimeter
Crossovers



SLR range residuals

CODE final GPS orbits

SLR observations are very useful for **independent validation** of microwave orbits.



PRECISION ORBITS for GIOVE-A

15th International Laser Ranging Workshop
Extending the Range

**GIOVE-A and GPS-35/36 satellite orbits:
analysis of dynamical properties based on
SLR-only tracking data**

S. Melachroinos, F. Deflelie, F. Perosanz, O. Laurain, R. Biancale, P. Exertier

16/10/2006
Canberra, Australia

Orbit determination for GIOVE-A using SLR tracking data

Claudia Urschl
G. Beutler, W. Gurtner,
U. Hugentobler, M. Ploner

October 16, 2006
claudia.urschl@aiub.unibe.ch

AIUB
Astronomical Institute University of Bern

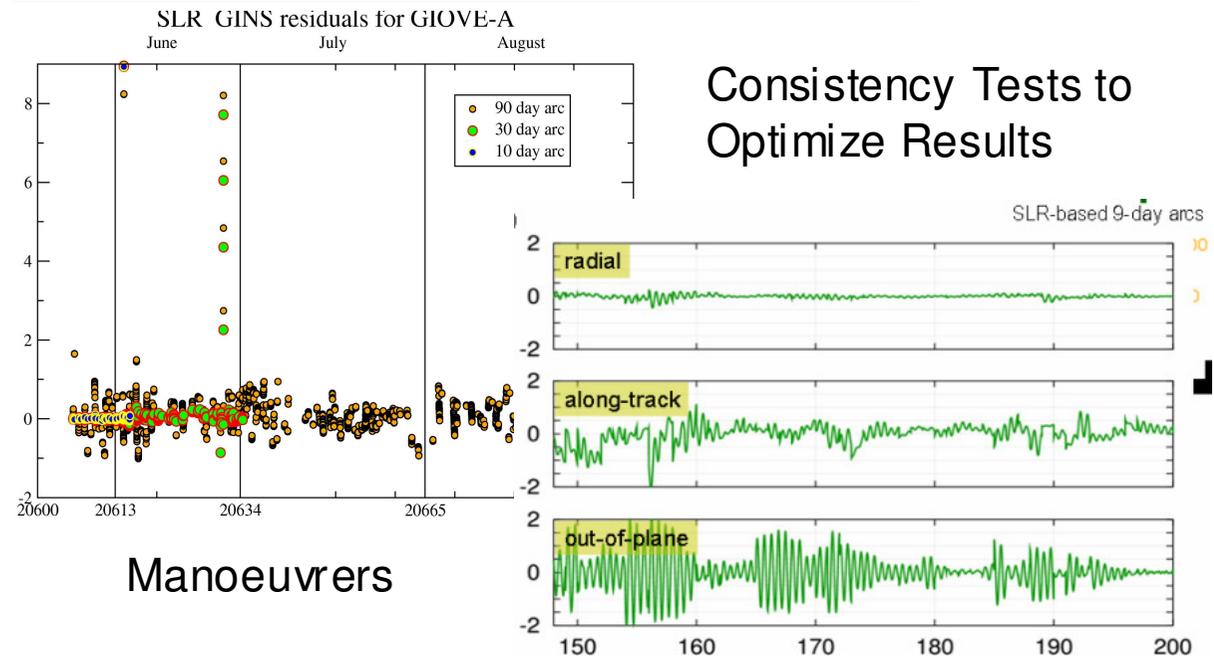
15th ILRS
Workshop
2006
Canberra
Australia
Oct 15-20

**Australian Government
Geoscience Australia**

Orbit Determination and Analysis of GIOVE-A Using SLR Data

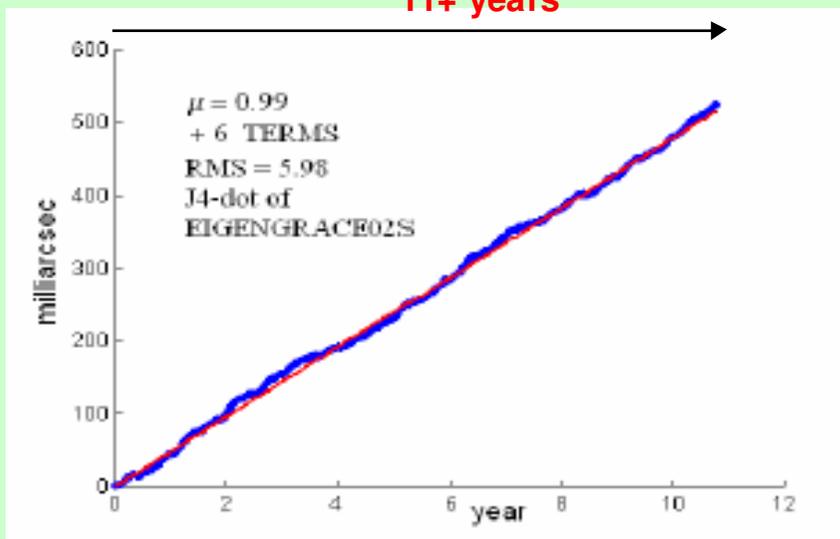
Ramesh GOVIND

15th International Laser Ranging Workshop
15th – 20th October 2006
Canberra

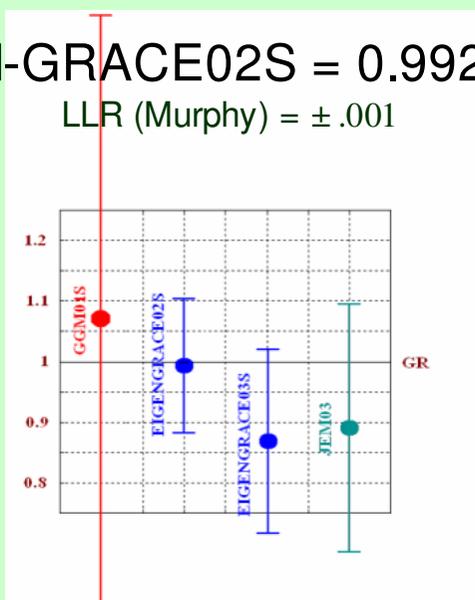


Lageos Node Combination Residual Compared to Predicted LT Effect (Pavlis)

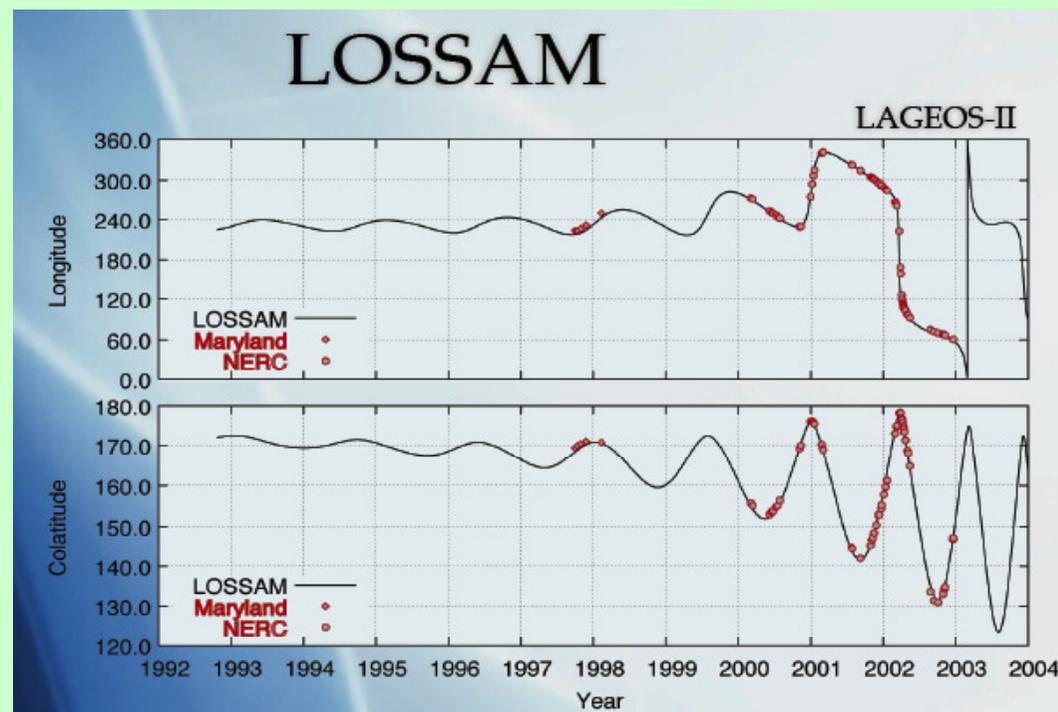
11+ years



μ EIGEN-GRACE02S = 0.992 ± 0.05
 LLR (Murphy) = $\pm .001$

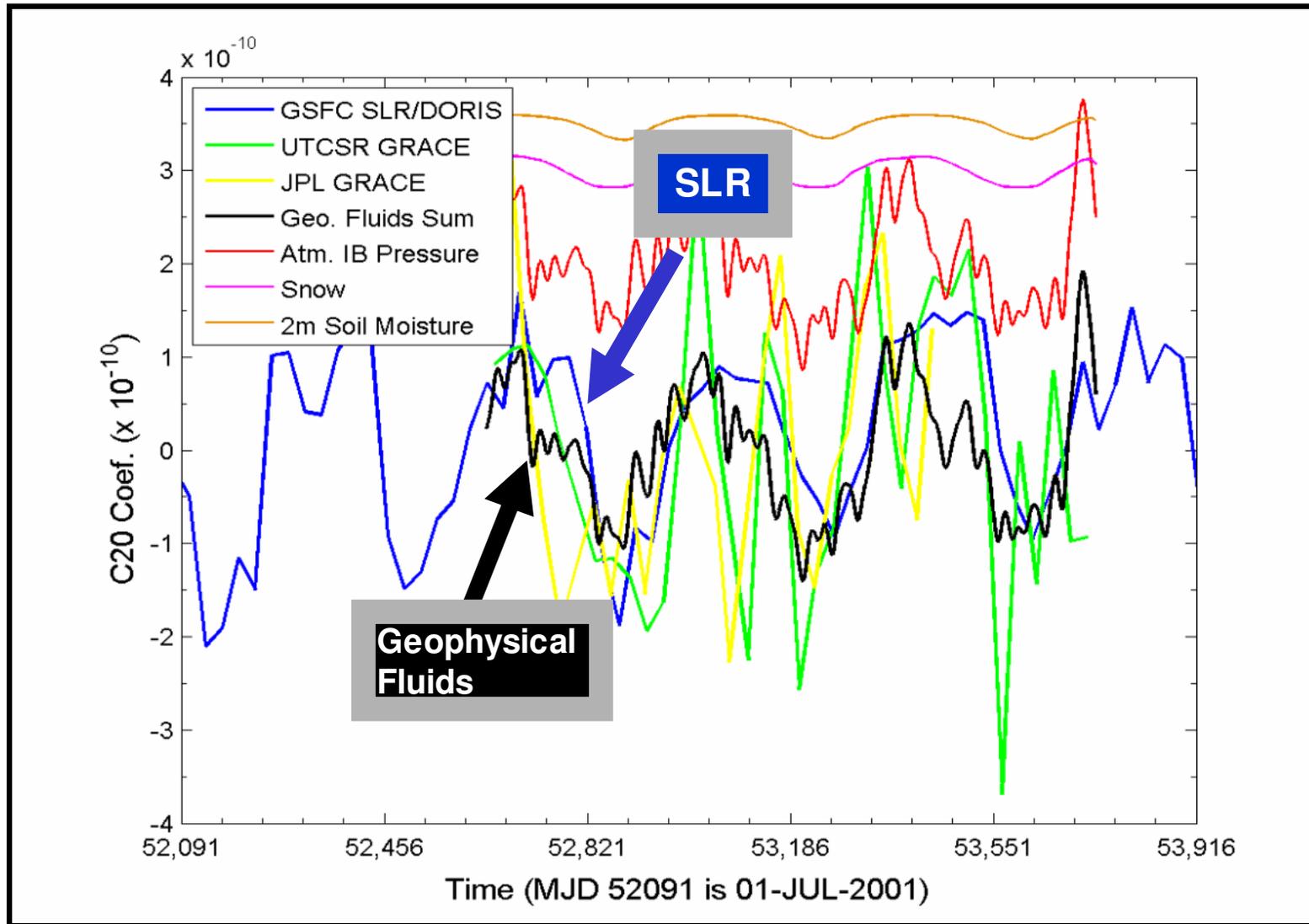


Lageos II Modeled and Observed Spin Orientation Needed for Advanced Thermal Models (Noomen); Lageos Spin Modeling (Kucharski)

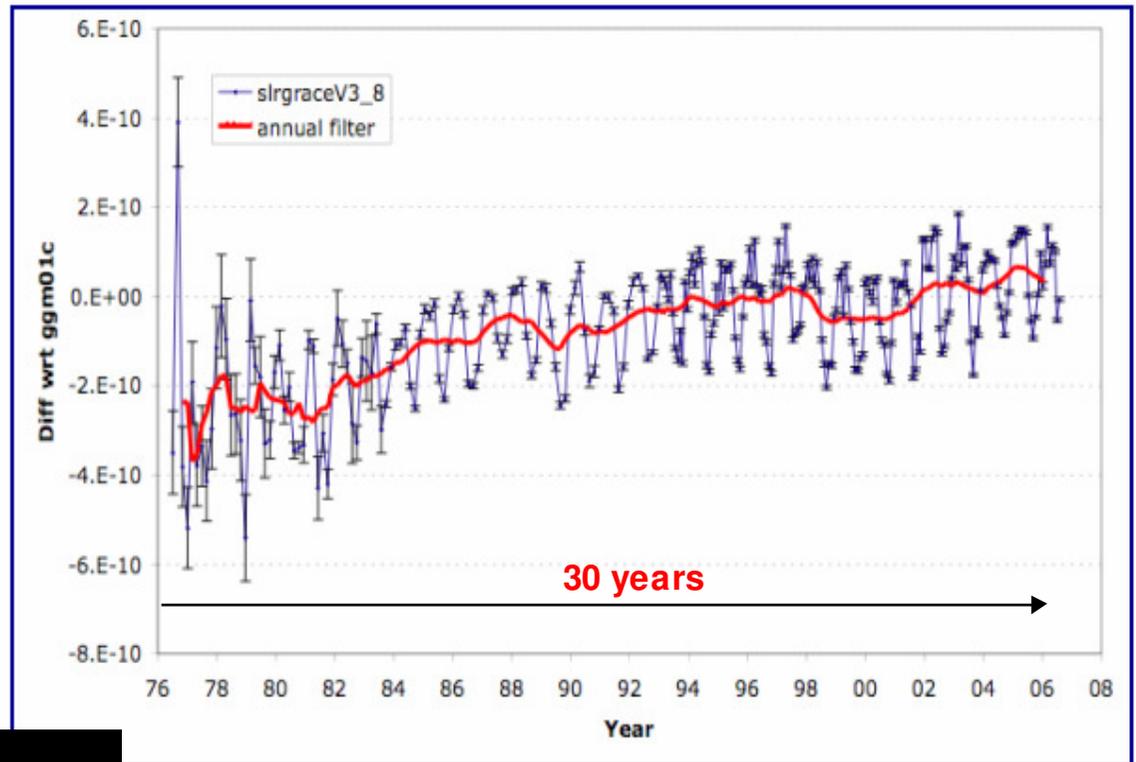


Advances in Physical Understanding

$C_{2,0}$: Comparison: SLR vs GRACE monthly (Lemoine)

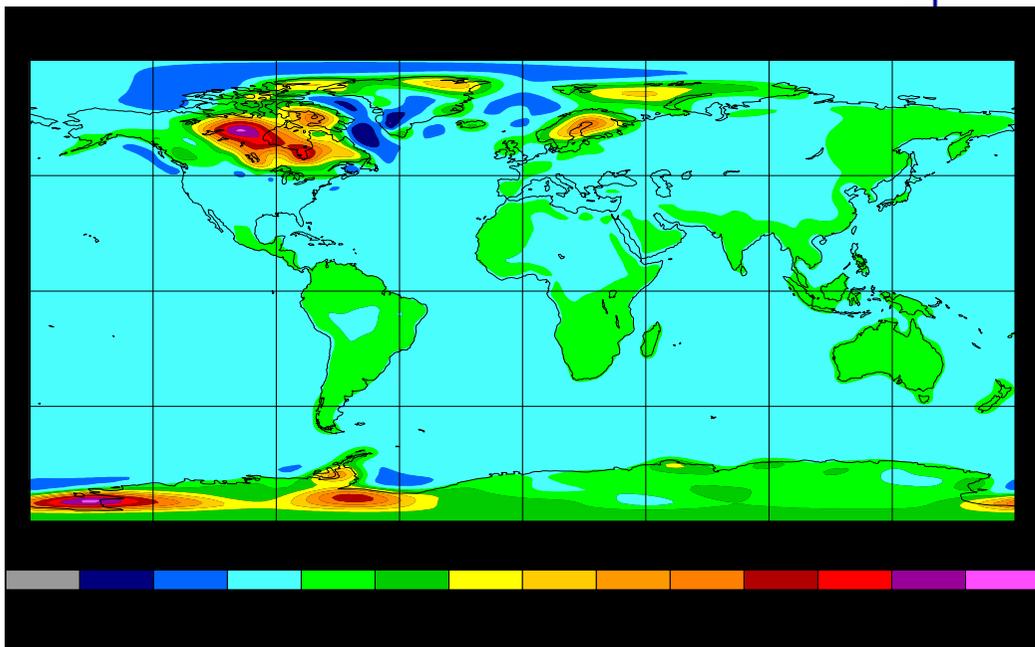


Rate of Radial Displacement Predicted from PGR Model Developed from ICE-5G (Peltier)



C2,0: SLR 30 yr Evolution (Lemoine)

Post Glacial Rebound



Terrestrial Reference Frame

(Polar Motion, Earth Rotation, Geocenter, Station Motion)

SUB-CM EARTH MEASUREMENTS

mm-level Geodesy requires understanding of the reference frame and its distortions to acute levels of precision.



Geospatial component

- Core research infrastructure to deliver a geodetic positioning capability of 1cm accuracy in real time and 1mm accuracy in post-event processing across the Australian region.
- To provide a capability for crustal deformation and environmental monitoring that will underpin the GeoTransect program and to provide a coherent and national framework for geospatial applications.



Katherine



VLBI

Station Positioning and the ITRF

- Introduction
- ITRF2005 Experience
 - Positioning Performance (where are we ?)
 - Accuracy of the Frame Parameters (Origin & Scale)
 - Limitation Factors & Issues for Improvement
- Conclusion

SLR

DORIS

GPS

IGN **Zuheir Altamimi**
IGN, France **GPS**

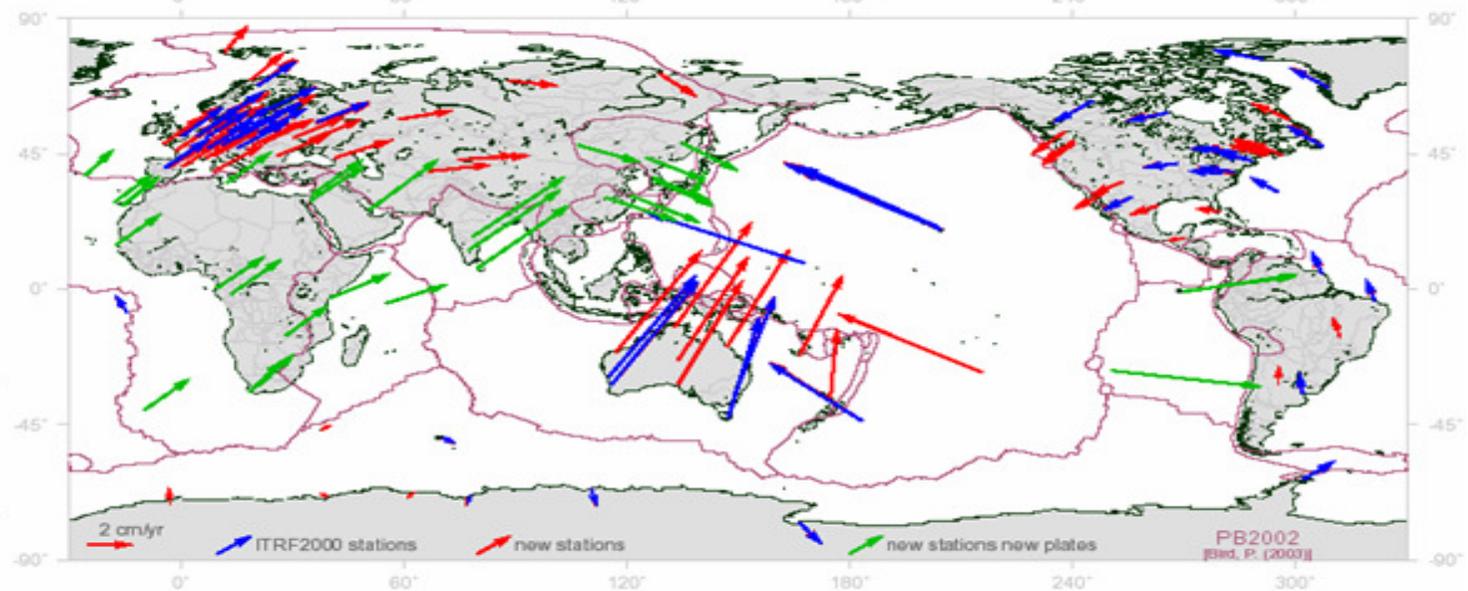
ILRS Workshop, Canberra, October 16-20, 2006

International Terrestrial Reference Frame

Example of selected sites for plate angular velocities estimation

Using PB 2002 Plate boundaries (Bird, 2003)

- Pacific
- Africa
- Amur
- Antarctica
- Arabia
- Australia
- Caribbean
- Eurasia
- India
- North America
- Nazca
- Okhotsk
- South America
- Somalia
- Yangtze





Determination of the Temporal Variations of the Earth's Centre of Mass from Multi-Year SLR Data

Ramesh GOVIND

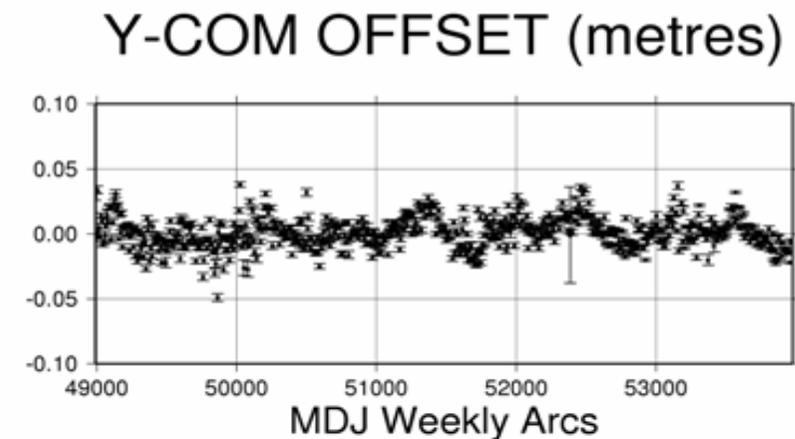
15th International Laser Ranging Workshop
15th – 20th October 2006
Canberra

Geocenter Monitoring Using SLR (Govind)

Lageos: COM Results

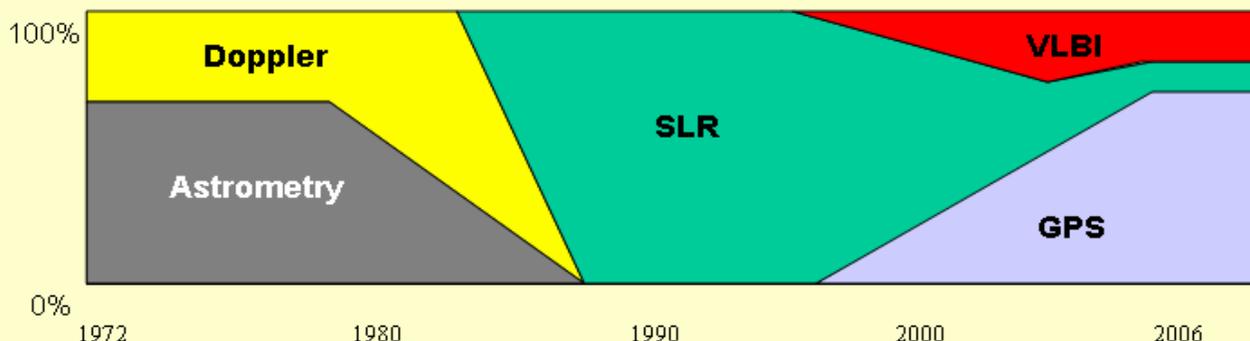
Dominant Periods

- ≈ 1200 days (39 months) – 2 cm
- ≈ 900 days (30 months) – 3 cm
- ≈ 18 months – 3 cm

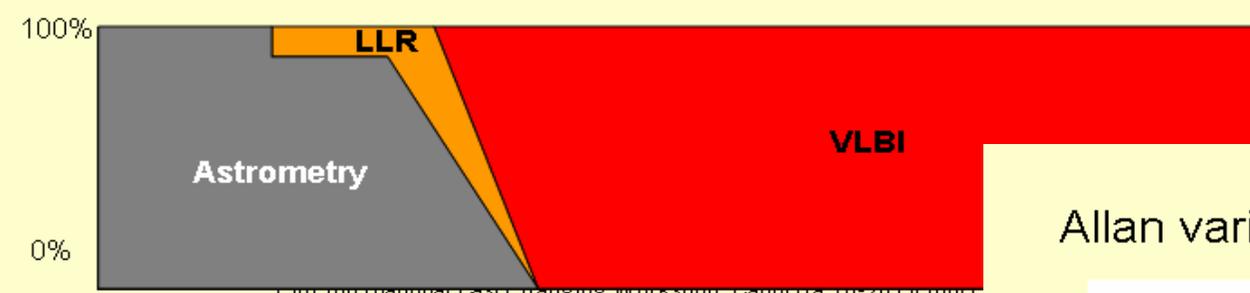


Contributions of techniques to EOP combined solutions

Polar Motion

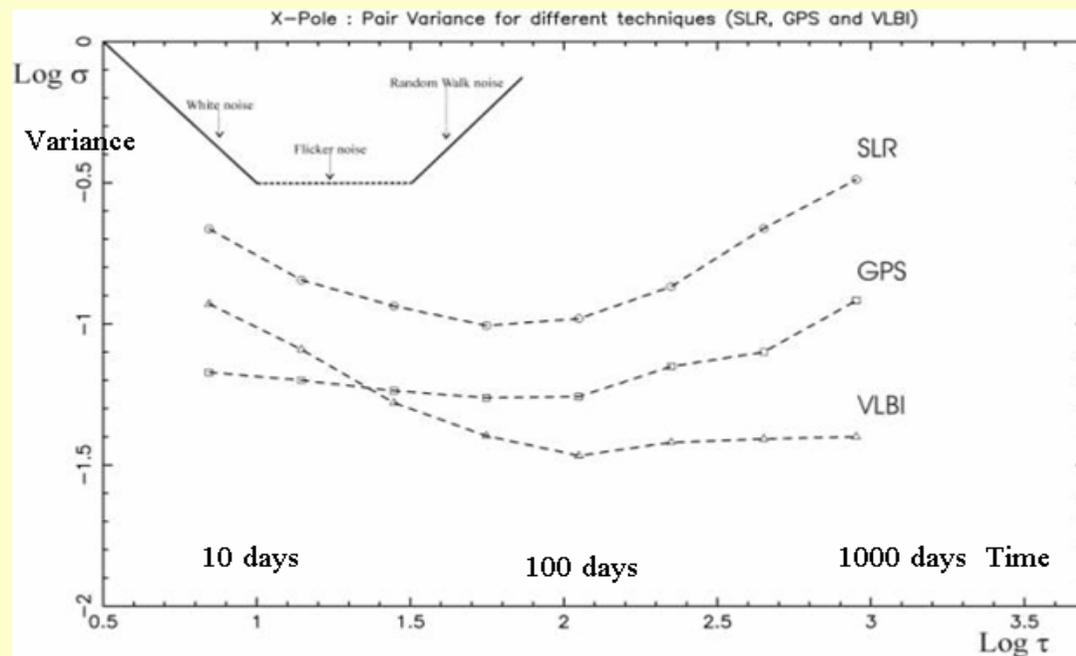


Universal Time



Optimal Combination of Techniques (Gambis)

Allan variance analysis for SLR, GPS and VLBI





*Least square mean effect.
Application to the analysis
of Satellite Laser Ranging time series*

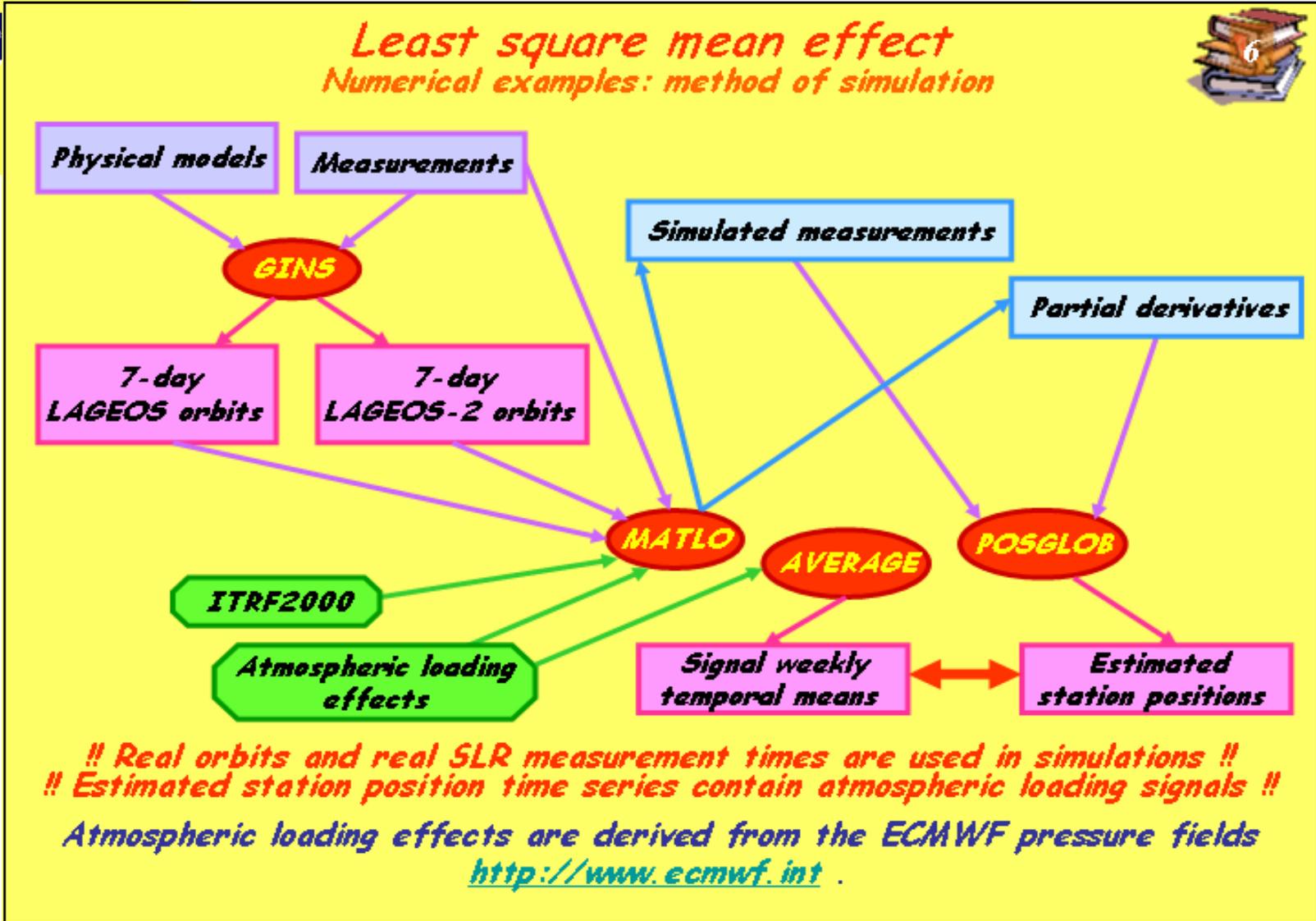
D. Coulot ⁽¹⁾, Ph. Berio ⁽²⁾ & A. Pollet ⁽¹⁾

*(1) IGN/Laboratoire de Recherche en Géodésie - Marna la Vallée - France
(2) OCA/Département GEMINI - Grasse - France*

Improved Treatment of Time Varying Signals (Coulot)

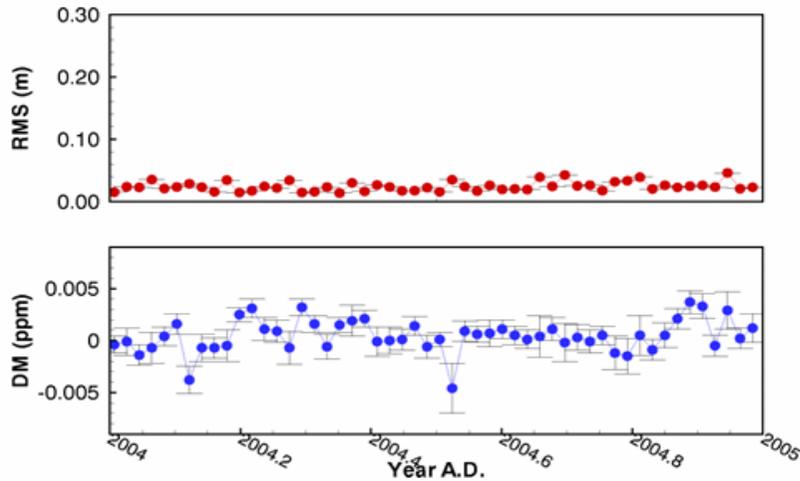


15th International Laser Ranging Workshop



DGFI

7-Param Transformation EPOS solution vs. ITRF2000:
Disclosures (RMS) vs. Scale (DM)



**AFTER
station disclosure
Screening**

**-> Some peaks in
scale removed**

Scale between SLR and VLBI

	Δ Scale offset [ppb]	Δ Scale drift [ppb/yr]
SLR - VLBI	0.40 ± 0.42	0.04 ± 0.10
SLR - VLBI *	0.26 ± 0.41	0.03 ± 0.09

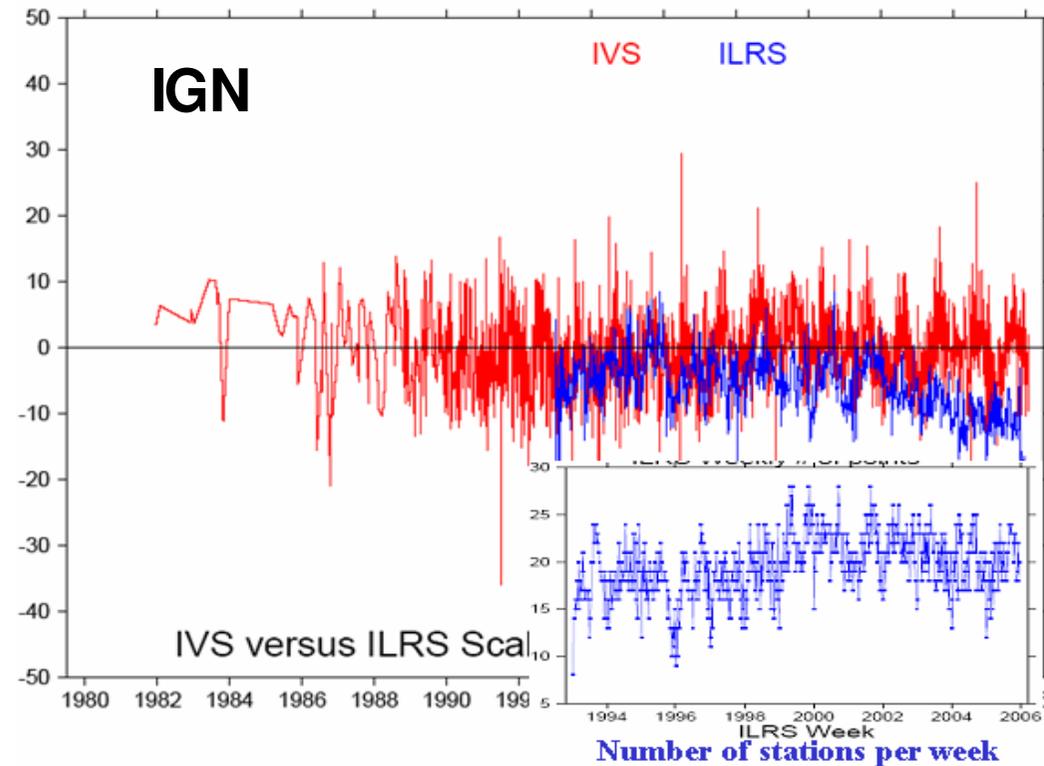
* : Discontinuity for GPS station Maui introduced

Some remarks:

- The scale difference between SLR and VLBI is obtained „indirectly“ via similarity transformations w.r.t. the GPS network.
- The estimated scale differences are very small and not significant.
- Much effort was made to select the „best“ co-location sites w.r.t. quality and spatial distribution.

SLR vs VLBI Scale: 1.7ppb???

VLBI vs SLR Scale wrt ITRF2005



Conclusions

- **Origin:**
 - Significant drift / ITRF2000 in TZ : 1.8 mm/y
 - **Consider Impact on ITRF2005 velocity field** (ITRF2005 velocities are 1.8 mm/yr larger than ITRF2000)
- **Scale:**
 - ~ 1 ppb bias btw solutions from VLBI and SLR
- **NNR Condition:** Still at the level of 2 mm/yr
- Still too many issues to improve ...

?

WWW Based Service to Compare Geodetic Time Series (Deleflie)

LABORATOIRE GEMINI : Reference System Database

http://maestro.obs-azur.fr/gemini/donnees/sys_ref2/sys_ref_list_with_sol.php

Cambridge Dictionary Apple Amazon France eBay France Yahoo! Informations (1802) Parole de Chti script csh SNB

laboratoire GEMINI du CNRS et département de l'OCA

présentation du labo équipes doctorants
thèmes de recherche projets et instruments publications observations & données

Reference System Database

Reference System
Query by technic
Query by parameters

Cart (0)
Logout

Help

Stations: 651

Unselected Stations: 0 Selected Stations: 651

1311A 404245001 KAUAI 9-m at Kokee
1404A 417055006 SANTI12 12-m at Santi
1513A 404055014 GOLDVENU This antenna
1515A 404055019 DSS15 34-m HEF at G
1543A 501035001 TIDBIN64 70-m DSS43 at

Start date: 8 4 1979 End date: 2 2 2006

Positions Velocities Residuals time series

Reset Parameters Submit

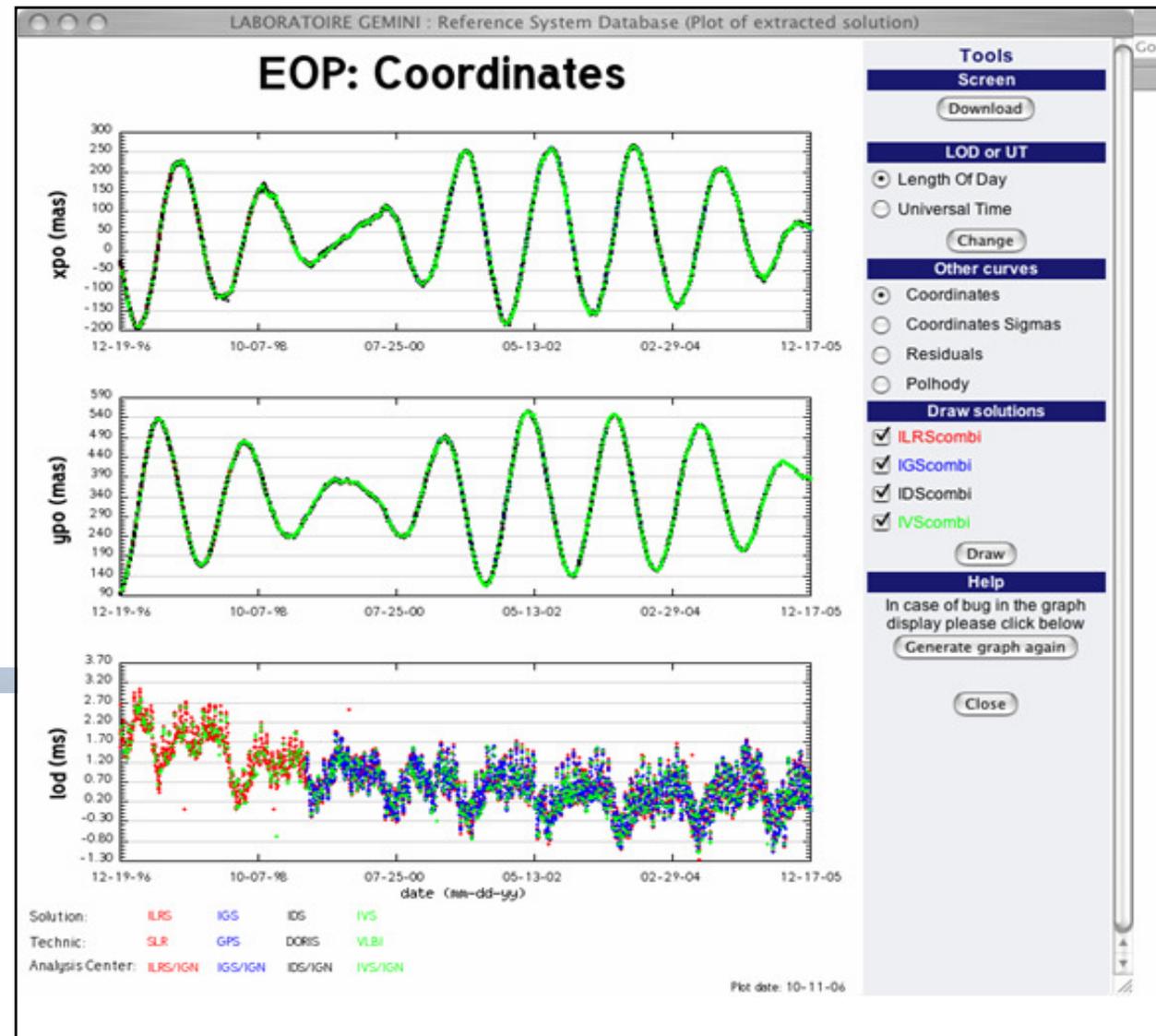
EOP: 5 solutions Transformation parameters: 5 solutions

Start date: 1 12 1993 3 31 2005 End date: 12 31 1992 12 30 2005

Polar Motion XP/YP residuals
 UT UT residuals
 LOD LOD residuals

Translations, Rotations and Scale factor

Reset Parameters Submit

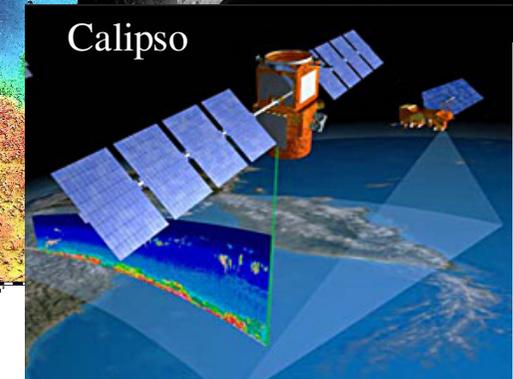
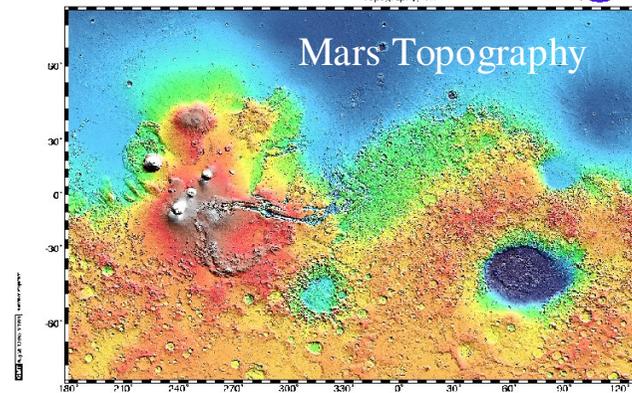
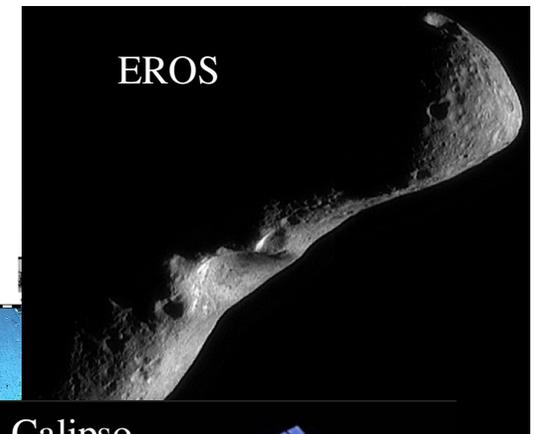
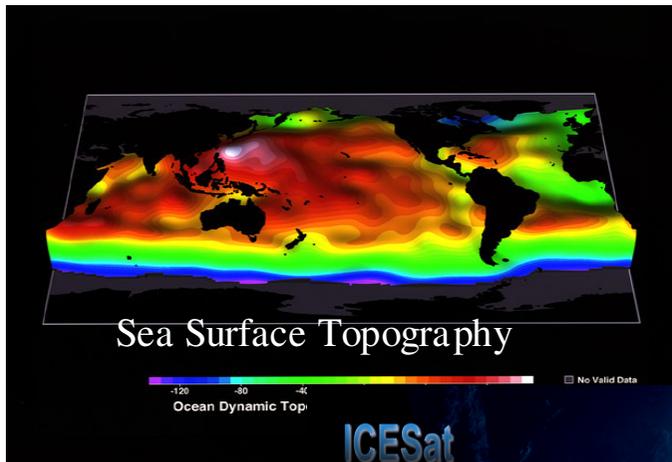


LASER SATELLITE ALTIMETRY

- Laser Altimetry

- Earth/planetary topography
- Biospheric monitoring
- Interplanetary applications

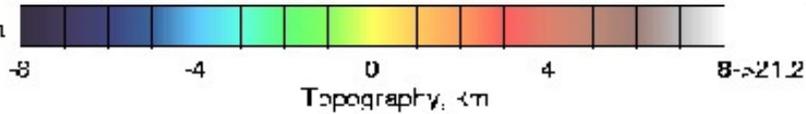
- *Mars Global Surveyor*
- *Near Earth Asteroid Rendezvous .*
- *ICESat*
- *Shuttle Laser Altimeter*
- *Lunar Reconnaissance Orbiter*
- *Mercury Messenger*



Mars Surface Topography from MGSIMOLA



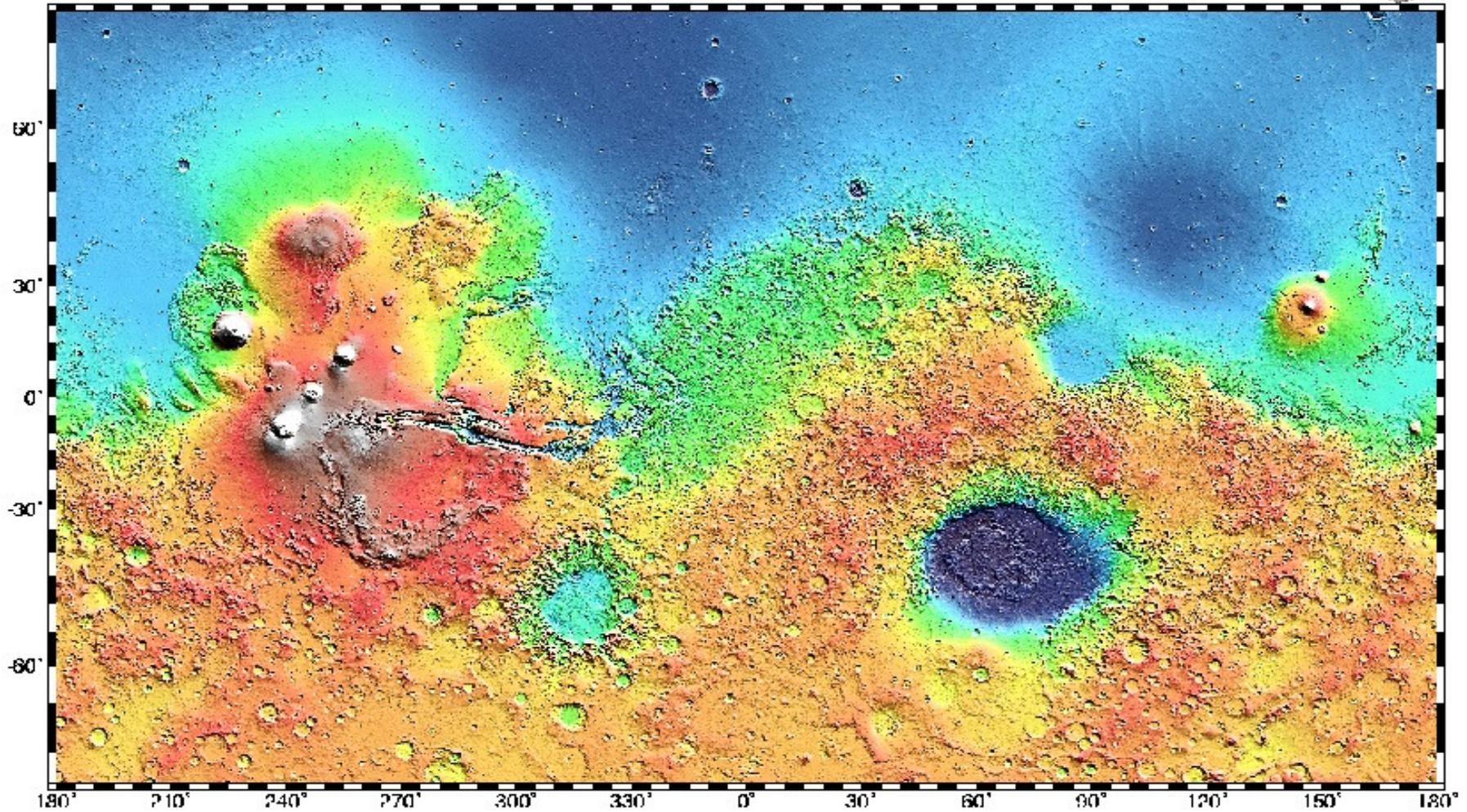
MOLA Science Team



NASA-Goddard
Space Flight Center

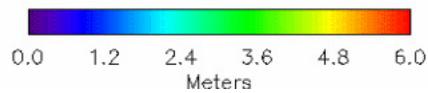
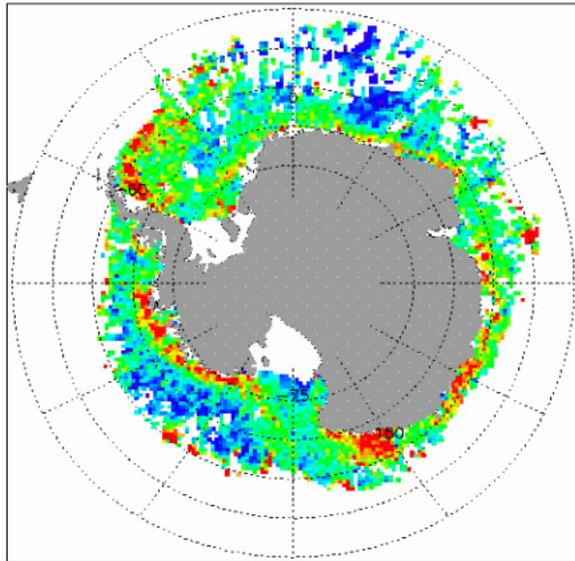


GIIT 6.3 at 12:00: 9/19/99

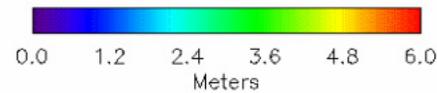
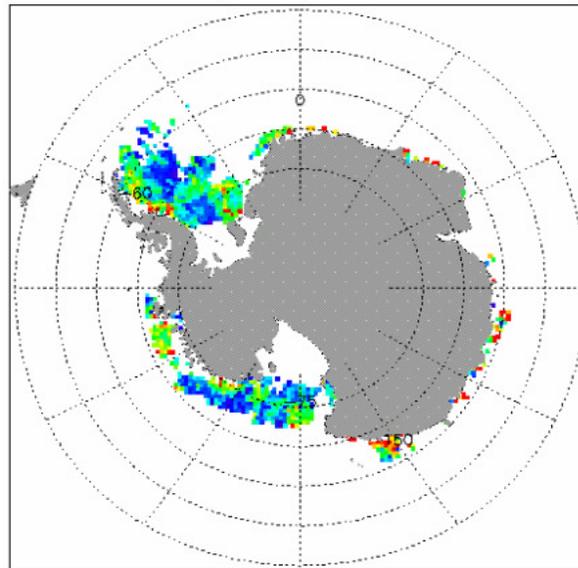


First Sea Ice Thickness Maps From ICESat

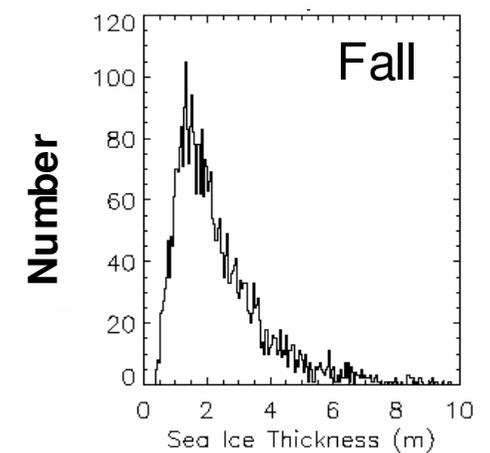
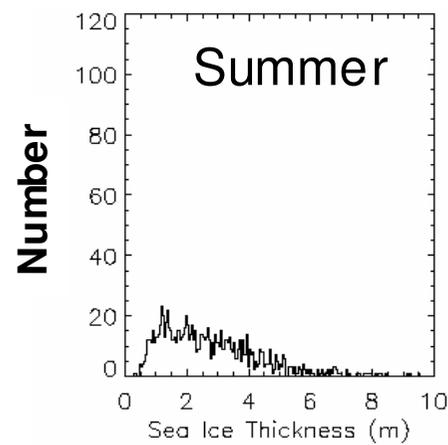
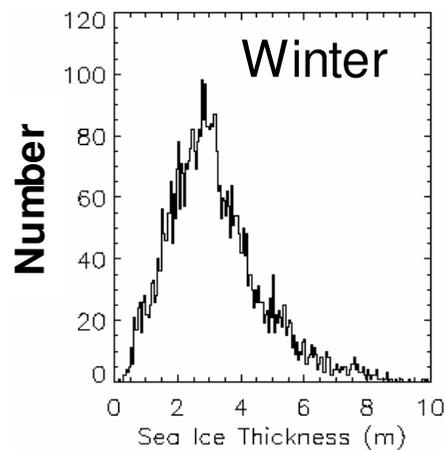
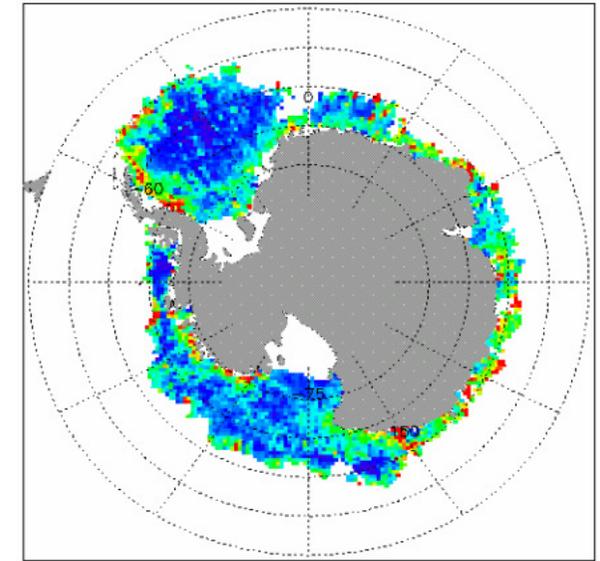
Sea Ice Thickness
Oct 4 – Nov 18, 03



Sea Ice Thickness
Feb 18 – Mar 21, 04



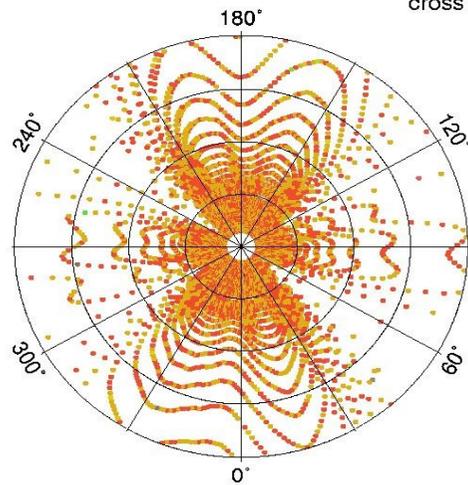
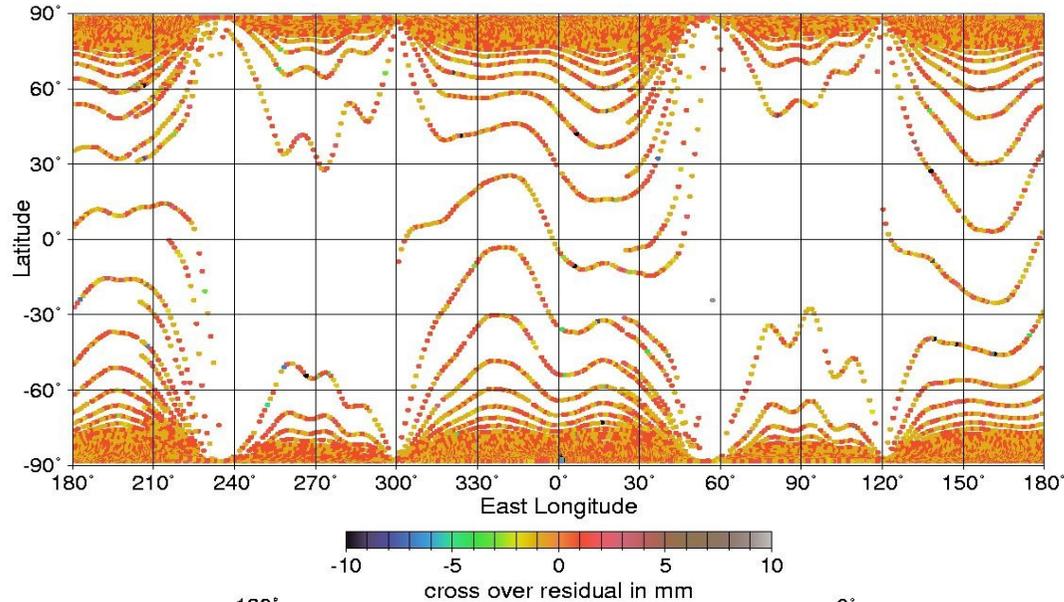
Sea Ice Thickness
May 15 – Jun 24, 04



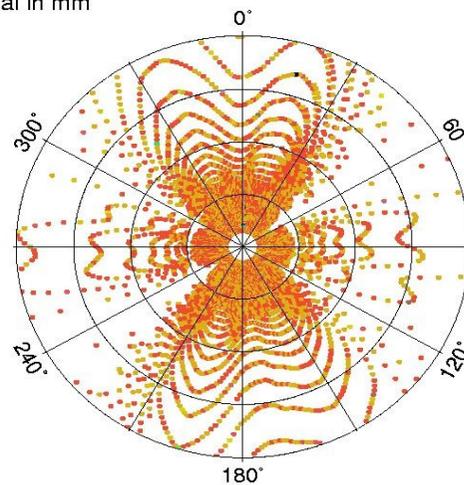
Lunar Laser Altimeter data

lunar laser altimeter crossover residual at surface point

max 16.6 min -19.8 ave 0.000599775 stdv 1.19415 total 14.4 for 24009 records



North Pole: latitude ge 70



South Pole: latitude le 70

SIMULATIONS FOR LRO

- Simulations of a Lunar Orbiter mission flying an altimeter were undertaken in support of GSFC's proposal for this round of Discovery Missions. These simulations assessed the efficacy of using altimeter cross over data to improve satellite positioning and gravity recovery on the far side of the moon

Summary

- **Observations Acquired by SLR, LLR, and Laser Altimetry are Major and Unique Science Resources**
- **Major Advancements in Modeling**
 - Gravity field accuracy
 - Astrodynamic forces
 - Thermal characterization of satellite components
 - SLR data analysis techniques and correction algorithms
- **Limitations**
 - Best SLR precision ~ 1-2 mm; Best orbit reductions ~ 1-2 cm
 - Significant signal remains to be understood and exploited
 - **Terrestrial Reference Frame:**
 - Results are currently analysis center specific and rely on processing approaches
 - Significant and pressing need for resolution